Computing spectra without solving eigenvalue problems

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Abstract

The puzzling and important phenonenon of wave localization arises
in many physical and mathematical contexts, with applications range
from the quantum mechanics of electrical conduction through the
design of optical devices to the construction of noise abatement
systems, to name but a few. Although studied by physicists and
mathematicians for the better part of a century, localization
of eigenmodes is still not fully understood nor controlled.
In this talk we will describe recent major strides which have
been made towards a comprehensive theory. In particular, it
is now possible to predict and control the spectrum–both the
eigenfunctions and the eigenvalues–of a large class of elliptic
PDE, such as Schrodinger operators with random potentials.
The talk will feature numerous high fidelity large scale finite
element computations which have played a crucial role in guiding
our understanding, validating theoretical results, and highlighting
mysteries as yet unexplained.

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